NATIONAL BUREAU OF STANDARDS REPORT

8673

PERFORMANCE TESTS OF TWO DEEP-BED HIGH EFFICIENCY AIR FILTERS

Conosac 85, Model 8-sac-24 and
Conosac 95, Model 9-sac-24

manufactured by
Continental Air Filters, Inc.
Louisville, Kentucky

by

Joseph C. Davis
and
Charles M. Hunt

Report to
General Services Administration
Public Buildings Service
Washington, D. C.

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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1. Introduction

At the request of the General Services Administration, the performance characteristics of a Continental Conosac 85 Filter, Model 8-sac-24, and two Conosac 95, Model 9-sac-24, were determined. These filters were of the deep-bed panel type employing a replaceable medium. The filters were manufactured by the Continental Air Filters, Inc., Louisville, Kentucky. The scope of the investigation included the determination of the arrestance of the particulate matter of the laboratory air by the filters, and the pressure drop across the filters at the rated air flow rate of 2000 cfm as the dust load was gradually increased from zero to a final value corresponding to a pressure drop of 1.0 in. W.G. for both Models 8-sac-24 and 9-sac-24.

2. Description of Test Specimens

The filters were manufactured and supplied by the Continental Air Filters, Inc. of Louisville, Kentucky. They were identified as "Conosac 95", Model 9-sac-24, made with a yellow fine glass fiber media (Owens Corning FM 003), and "Conosac 85", Model 8-sac-24, made with a pink medium glass fiber media (Owens Corning FM 004). In each specimen, the filter medium was secured to No. 20 mesh dacron. The filter mat with its dacron mesh backing was formed into six pockets, 35 inches deep and 31 inches wide, presenting an effective filtering surface of approximately 90 sq. ft.

The gross face area of each of the filter units was 3.84 $ft.^2$, but the enclosing edges of the metal frame reduced the net face area to 22" x 22", or 3.36 $ft.^2$

At a rated air flow of 2000 cfm, the net face velocity was approximately 600 ft/min and the average velocity through the filter medium was about 22 ft/min.

The manufacturer furnished square frames made of 2- x 3/4-inch steel angle, electro-galvanized, into which the filter units were placed during operation. The frames had overall dimensions of 24" x 24", with polyurethane gaskets to prevent air leakage when the filters were in operation. The weight of the clean filters was approximately 1800 grams (4 lbs.).

3. Test Method and Procedure

The filter under test was installed in the test apparatus and carefully sealed to prevent by-pass of air or inward flow of air into the test apparatus except through the measuring orifice at the entrance to the test duct. The construction of both filters was such that the method of mounting was important. To obtain maximum performance of each filter, it was necessary that the pleats did not sag materially, that their extension during the testing was not impeded by faulty fastening of the media to their frames, and that none of the pleats remained collapsed in the air stream. It is suggested that these precautions be taken during use of these filters in government installations.

The filters were tested at an air flow rate of 2000 cfm. The arrestance determinations of each specimen were made with the NBS Dust Spot Method described in a paper by R. S. Dill entitled, "A Test Method for Air Filters" (ASHVE Transactions, Vol. 44, page 379, 1938).

After establishing the correct air flow rate through the filter, samples of air were drawn from the center points of the test duct 2 feet upstream and 8 feet downstream of the test specimen. Each sample of air was passed through Whatman No. 41 filter paper. Arrestance determinations were made with the particulate matter in the laboratory air as the aerosol.

The light transmission of the sampling papers was measured on the same part of each paper before and after test, and the two sampling papers used for any one arrestance determination were selected to have the same light transmission when clean.

Since there is a higher aerosol concentration upstream from the test filter than downstream, it is necessary to adjust sampling to obtain approximately equal discoloration of the upstream and downstream sampling papers. In most of these tests this was accomplished through the use of sampling plates of different areas to hold the upstream and downstream sampling filters. Percent arrestance, A, was then calculated by the relationship,

$$A = \left(1 - \frac{S_d}{S_u} \times \frac{\Delta D}{\Delta U}\right) 100$$

where S_d and S_u are the downstream and upstream sampling areas, and ΔD and ΔU are the respective change in opacity of the downstream and upstream sampling papers.

With one of the Model 9-sac-24 filters, sampling was done both with sampling plates of different areas and with a timer, and the results of the two methods were compared. In the timer method, upstream sampling is intermittent while downstream sampling is continuous

throughout the sampling period. Percent arrestance, A, is calculated by the formula,

$$A = \left(1 - t \frac{\Delta D}{\Delta U}\right) 100$$

where t is the fraction of the total time sampled upstream, and the other symbols have the same meaning as before.

Arrestance measurements were made with each filter in the unloaded condition and after adding increasing increments of a test dust consisting of 96 parts of Cottrell precipitate and 4 parts cotton lint. The Cottrell precipitate had previously been sifted through a 100-mesh sieve, while the lint was prepared by grinding No. 7 cotton linters through a Wiley mill with a 4-millimeter screen.

The pressure drop across the filter under test was recorded at the beginning of the test, after each arrestance determination, and after each increment of Cottrell precipitate and lint that was introduced into the test duct. The test was terminated when the pressure drop reached approximately 1.0 in. W.G. across the filter.

4. Test Results

The test results obtained with the Conosac 85 Model 8-sac-24 filters are summarized in Table 1.

Table 1. Performance Characteristics of Conosac 85 Model 8-sac-24 Filters at 2000 cfm Air Flow Rate

Nominal dust load[a]			Arrestance[b]	Pressure drop across filter
Cottrell precipitate Grams	Lint Grams	Total Grams	Percent	Inches W. G.
1st Filter				
0	0	0	77.3	0.546
140	5.8	146	79.1	.588
360	14.9	375	79.6	.642
600	24.9	625	81.3	.710
840	34.9	875	83.4	.800
1080	44.8	1125	84.9	.900
1260	52.3	1312	87.5	1.026
Average arrestance[c]	82.0%			
2nd Filter				
0	0	0	76.5	.562

[a]Nominal dust load is the total cumulative weight of Cottrell precipitate and lint introduced into the test duct. The actual load retained by the filter is less than the nominal load by the amount which passes the filter.

[b]Arrestance values obtained with atmospheric dust using sampling plates of different area downstream and upstream

[c]Average arrestance, $\bar{A}$, is based upon a graphical estimate of the relationship,

$$\bar{A} = \frac{\int_0^{L\ Total} AdL}{L\ Total}$$

where A is the arrestance at a nominal load of L, and $\int_0^{L\ Total} AdL$ is the area under the curve of arrestance vs. load.

In Figure 1 arrestance and pressure drop across the Conosac 85 Model 8-sac-24 filter are plotted as functions of nominal dust load. From the upper curve an average arrestance of 82.0 percent is calculated. From the lower curve the amount of test dust required to produce a pressure drop of 1.0 in. W.G. is estimated to be 1280 grams. This corresponds to 381 grams per ft^2 of net face area or 14.2 grams per ft^2 of filter media.

The test results obtained with the 9-sac-24 filters are presented in Table 2.

Table 2. Performance Characteristics of Conosac 95 Model 9-sac-24 Filters at 2000 cfm Air Flow Rate

Nominal dust load[a]			Arrestance[b]			
Cottrell precipitate Grams	Lint Grams	Total Grams	Sampling plate	Timer percent	Average (Sampling plate and timer)	Pressure drop across filter Inches W.G.
1st Filter						
0	0	0	---	89.6	---	0.606
140	5.8	146	---	91.9	---	.640
280	11.6	292	---	91.5	---	.684
480	19.9	500	---	91.2	---	.766
620	25.7	646	---	92.0	---	.852
860	35.7	896	---	93.4	---	1.012
Average arrestance[c] 92.0%						
2nd Filter						
0	0	0	90.3	91.3	90.8	0.598
140	5.8	146	90.3	90.0	90.2	.646
280	11.6	292	91.3	91.4	91.4	.690
480	19.9	500	91.2	90.9	91.1	.766
680	28.2	708	93.9	---	---	.870
880	36.5	917	94.5	94.4	94.5	1.020
Average arrestance[c] 92.2%						
3rd Filter						
0	0	0	90.1	---	---	.580

[a], [b], [c] See footnotes at bottom of Table 1.

In Figure 2 the data for the first two Conosac 95 Model 9-sac-24 filters are presented graphically, as an average. From the upper curves average arrestance values of 92.0 and 92.2 percent were obtained for the first and second filters, respectively. The close agreement between the two values may be somewhat fortuitous in view of the scatter of individual points. Scatter of individual points greater than this has been reported for some deep-bed-type filters in NBS Report No. 8001, and it was suggested to be due to dislocation of the dust in the filter pockets when the air flow was cut off.

5. Summary

Some of the pertinent data relating to the performance of the 8-sac-24 and 9-sac-24 filters is summarized in Table 3.

Table 3. Summary of Performance of Conosac Filters

Model No.	Conosac 85 8-sac-24		Conosac 95 9-sac-24		
	1	2	1	2	3
Air flow rate (cfm)	2000	2000	2000	2000	2000
Initial pressure drop (in. W.G.)	0.546	0.562	0.606	0.598	0.580
Recommended final pressure drop (in. W.G.)	1.0	1.0	1.0	1.0	1.0
Dust load at 1.0 inch pressure drop (grams)	1280	---	850	890	---
Estimated net face area (ft^2)	3.36	3.36	3.36	3.36	3.36
Estimated filter area (ft^2)	90	90	90	90	90
Initial arrestance with atmospheric dust (percent)	77.3	76.5	89.6	90.8	90.1
Average arrestance with atmospheric dust (percent)	82.0	---	92.0	92.1	---

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CONTINENTAL AIR FILTER

CONOSAC 85 MODEL 8-SAC-24

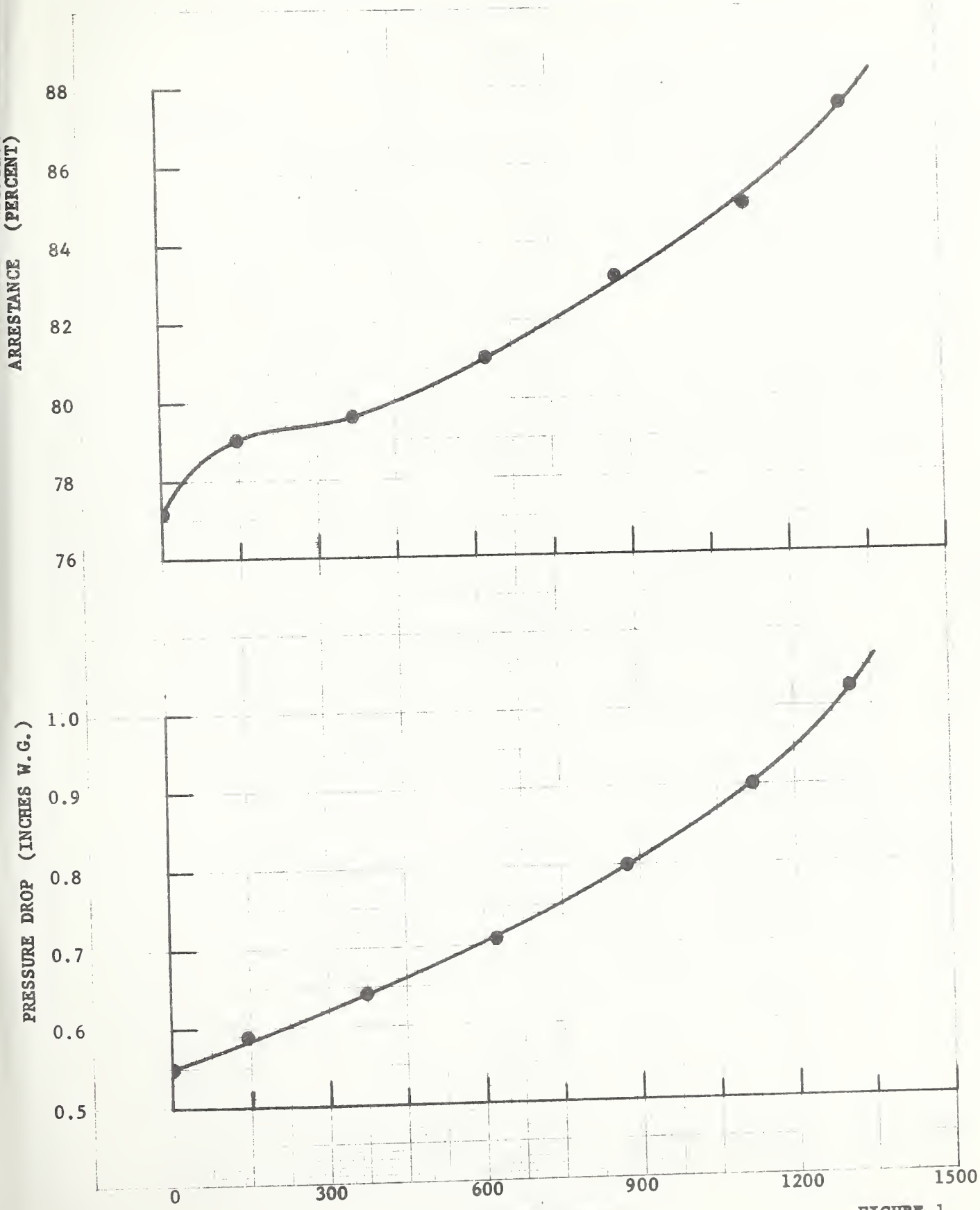

FIGURE 1

CONTINENTAL AIR FILTER

CONOSAC 95 MODEL 9-SAC-24

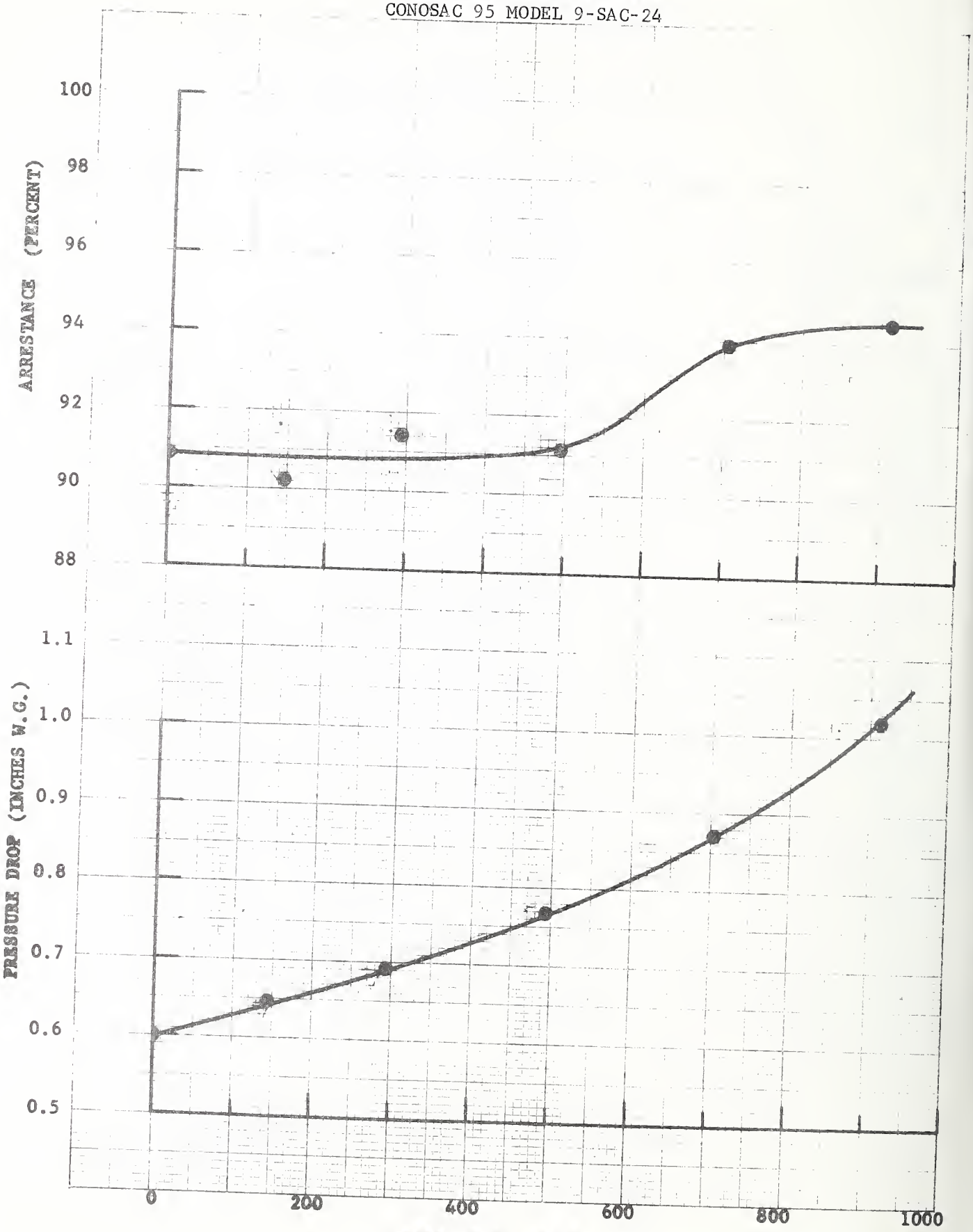

FIGURE 2

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